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The Growth of Body Size and Somatotype of Javanese Children Age 4 to 20 Years

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Growth of body size (body height and body weight) and somatotype in 363 girls and 299 boys aged 4 to 20 years of ethnic Javanese lived in Magelang Regency Indonesia were studied cross-sectionally. Over half of them were categorized in the well-off family, therefore underweight or underfat prevalence in our subjects was low (14.3%) but overweight and obesity prevalence was also low (14%). They were shorter and lighter than reference children from U.S., Japan and Yogyakarta but they improved when compared with those of the same ethnic of Bantul and with the different ethnic of rural India. There was a clear age-related change of their somatotype. At age 4 years, the physique of children subjects in both sexes is found to be mesomorph-endomorph. Thereafter it is transformed into ectomorphic-endomorph in girls and to mesomorph-ectomorph in boys at the age of 20 years. In girl subjects, the onset of puberty was characterized by an acceleration of endomorphy component at age 8 years. While in our boys it was characterized by an acceleration of ectomorphy since age 9 years. The different growth pattern of somatotype components showed that the use of BMI as an indicator of fatness in children should be reassessed.

Key words: growth, Javanese children, body size, body mass index, somatotype

INTRODUCTION

Numerous studies have been carried out in Indonesia to evaluate variations of the principal anthropometric characteristics in relation to growth (Adhianto & Soetjiningsih 2002; Puspita 2004; Rahmawati *et al*. 2004; Waters *et al*. 2004; Artaria & Henneberg 2007; Hermawan 2007; Miharja 2008; Tuan & Nicklas 2009; Aryo 2011). Growth is the best global indicator of children's well-being. It is the single measurement that best defines the health and nutritional status of children, just as it provides an indirect measurement of the quality of life of an entire population (de Onis & Blössner 2003). During the human growth, the body changes significantly in size and shape (Kalichman & Kobyliansky 2006). Body weight and body height are the main dimensions of body size.

Based on the 2-component model of body composition (Ellis 2000), body weight consists of fat mass and fat free mass. Fat mass is the most variable component of the body. A common indicator for fat mass is body mass index (BMI) (Dietz & Bellizzi 1999; Chakraborty *et al*. 2009; Kulkarni *et al*. 2010), which is defined by World Health Organization (WHO) as a simple index of weight-for-height (http://apps.who.int/bmi/index.jsp). It has been recommended as the best measurement for monitoring overall body adiposity in the majority of large-scales studies although BMI does not singly quantitate body fat as it amalgamates frame size (which reflects mineral content) and lean tissue (Roemmich *et al*. 1997; Fields & Goran 2000). On the other hand, skinfold thickness is widely used as a measure of fatness (Norgan 2005). It has most of the characteristics of a good field method to measure level of fatness because it directly measures subcutaneous fat layers. Nevertheless, a study of body weight and height only is not always sufficient enough to produce complete information regarding child physique and growth (Özener & Duyar 2008).

Independent of body size, a somatotype is a convenient shorthand descriptor of overall physique in terms of body shape and composition (Carter 1996). It reflects an overall outlook of the body and conveys a meaning of the totality of morphological features of the human body (Singh *et al*. 2007). A three-exact decimal score of component of somatotype refers to endomorphy (representing relative fatness), mesomorphy (representing relative muscularity) and ectomorphy (representing relative linearity) (Carter 2002). Somatotype has often been used to study morphometric variations in human body (Singh *et al*. 2007). Changes in somatotype components during the growth period can provide useful information about the growth status and the timing and rate of sexual maturation (Beunen *et al*. 1987; Hebbelinck *et al*. 1995; Toselli & Gruppioni 1999). Many studies were carried out in the Caucasoid children (Gakhar & Malik 2002; Ghosh & Malik 2004; Kalichman & Kobyliansky 2006; Bhasin & Jain 2007; Singh *et al*. 2007; Özener & Duyar 2008; Ventrella *et al*. 2008). Studies on somatotype in Indonesian children had not been well described excepting some reports from Rahmawati *et al*. (2004) and Aryo (2011).

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Indonesia has a wide variety of ethnological groups so it is important to carry out research into the growth of body size and somatotype. In the present study, we selected children from the Javanese population in Magelang Regency. The purpose of the study is to evaluate growth of body size (height and weight) and somatotype in the Javanese children aged 4 to 20 years from Magelang Regency. The growth of body size of the Magelang children is compared to that of several reference populations. Data recommended by the 2002 National Health Examination Surveys (NHES) and National Health and Nutrition Examination Surveys (NHANES) reference population (NHES & NHANES 2002) are the most suitable for use as an international growth reference (Bener & Kamal 2005). We also used reference children living in Japan (Kimura 1984), India (Venkaiah *et al*. 2002), and Indonesia (Bantul and Yogyakarta) (Rahmawati *et al*. 2004).

MATERIALS AND METHODS

Subjects. The subjects were ethnic Javanese lived in Magelang Regency. Magelang Regency is mainly a rural region with a land area of 1,085.73 km^2 comprised of 21 sub-districts. The regency is located in the Kedu Plain between Mount Merbabu, Mount Sumbing and Mount Merapi in Central Java, Indonesia (Figure 1). *It* has an average elevation of about 360 meters *above sea level*. The regency is located 43 km north of Yogyakarta and 75 km south of Semarang, the capital of Central Java. According to the Indonesia's Central Agency on Statistics (BPS 2006), it had an estimated population of 1,179,867 with age cohort 0 to 24 years comprised of 276,642 boys and 263,285 girls. A cross-sectional growth study was conducted during October 2008 to October 2009. Before enrolling, all the parents or child guardians were sent a letter with detailed information, in which their children were invited to participate in the study. If they approved to participate, they were asked to write an informed consent and completed a questionnaire on their child's birth dates, ethnicity and other demographic data. Age (in year) was determined by calculating the difference between the date of measurement and the date of birth and the difference was divided by 365.25 days. In trying to get growth norms, we eliminated outliers because they may be suspected as in abnormal health condition. These outliers were detected as individuals beyond 3rd and 97th percentiles in preliminary analysis of the whole data (see Data Analysis).

Measurements. In order to determine body size and somatotype we measured 10 anthropometric measurements, i.e. body weight (WT), body height (HT), triceps skinfold, subscapular skinfold, supraspinale skinfold, calf skinfold, humerus breadth, femur breadth, upper-arm girth, and calf girth. We followed the anthropometric measurement manual of NHANES III (1988). WT and HT are the main dimensions of body size.

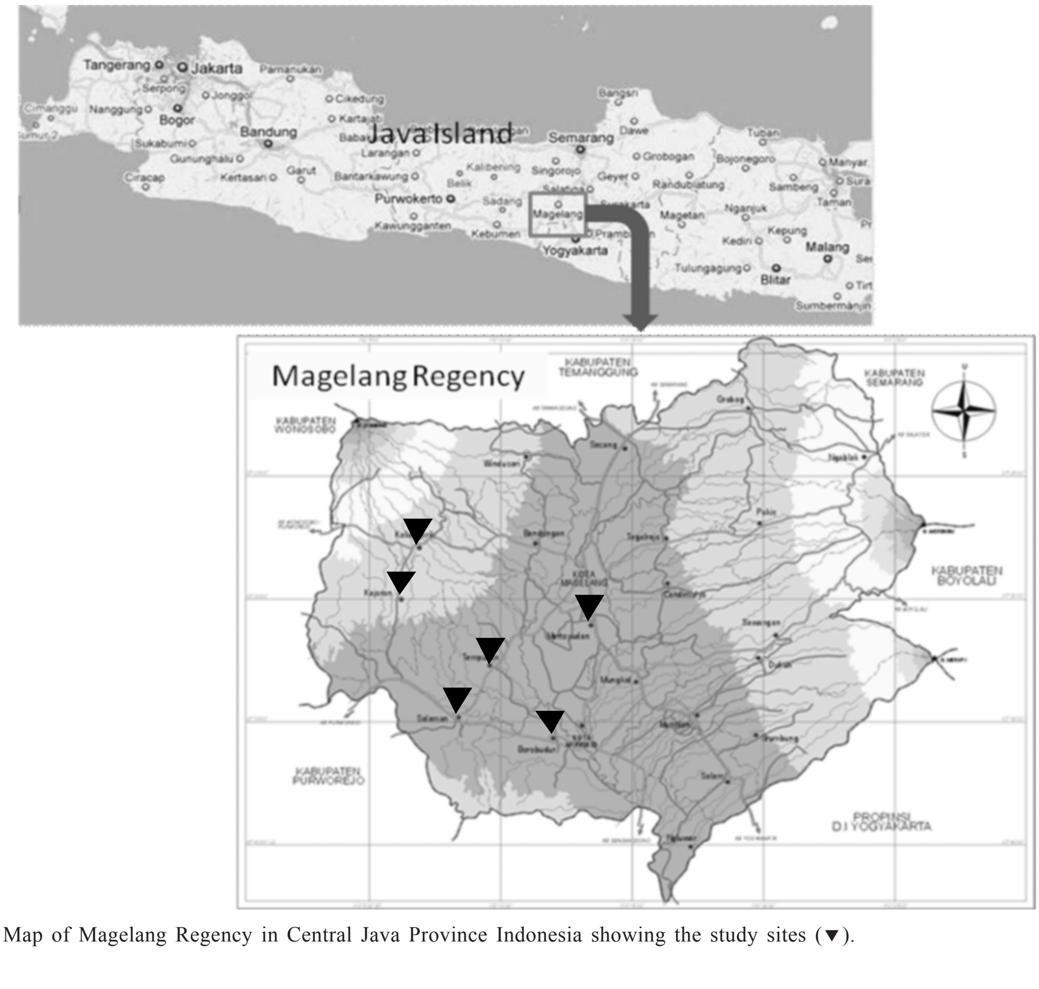

Figure 1. Map of Magelang Regency in Central Java Province Indonesia showing the study sites (▼).

WT consists of fat mass (FM) and fat free mass (FFM). FM is the most variable component of the body. An indicator for FM is body mass index (BMI, in kg/m^2) (Dietz & Bellizzi 1999; Kulkarni *et al*. 2010) which was computed following the standard formula of WHO, $BMI = weight/height^2$ (http://apps.who.int/bmi/index.jsp). Skinfold thickness is widely used as a measure of fatness (Norgan 2005), because it directly measure subcutaneous fat layers. Various estimation equations have been derived to determine whole body fatness from skinfold measurements on some anatomical sites. Equation of Slaughter *et al*. (1988) had been used to estimate percentage of body fat (PBF) among children age 8-18 years of various ethnic groups (Wong *et al*. 2000; Morrison *et al*. 2001). The equation follows the standard sex-specific and applies 2 skinfolds thickness, triceps skinfold (T) and calf skinfold (C). The PBF equations used in boys was $PBF(\%) = (1.33(T+C)) - (0.08(T+C)^2) - 3.533$ while in girls was $PBF(\%) = (1.33(T+C)) - (0.013(T+C)^2) - 2.5$.

All ten anthropometric dimensions above were needed to calculate the anthropometric somatotype. Equations for its calculation followed Heath-Carter method that resulted in a three-exact decimal score of endomorphy, mesomorphy and ectomorphy (Carter 2002). $Endomorphy = -0.7182 + 0.1451(X) - 0.00068(X^2) + 0.0000014(X^3)$ where X = (sum of triceps, subscapular and supraspinale skinfolds). $Mesomorphy = [(0.858 \times humerus\ breadth) + (0.601 \times femur\ breadth) + (0.188\ corrected\ arm\ girth) + (0.161 \times corrected\ calf\ girth)] - (height \times 0.131) + 4.5$ and $ectomorphy = HWR \times 0.732 - 28.58$ if HWR was greater than or equal to 40.75. HWR (height weight ratio) was body height divided by cube root of body weight. If HWR was less than 40.75 but more than 38.25, then $ectomorphy = HWR \times 0.463 - 17.63$ and if HWR was equal to or less than 38.25 given a rating of 0.1.

Data Analysis. All anthropometric data were statistically analyzed in the Section of Biosystematic and Ecology of Animals Department of Biology, Bogor Agricultural University. WT, HT, BMI, and PBF were presented as growth charts at 9 levels of percentiles (3, 5, 10, 25, 50, 75, 90, 95, and 97%) which were drawn by applying generalized additive models for location, scale and shape (GAMLSS) (Rigby & Stasinopoulos 2005). In somatotyping, the three-number somatotype scores were determined; individuals represented by the somatotype scores were plotted on a two-dimensional somatochart (somatoplot) using X,Y coordinates derived from the score (Carter 2002). $X\ coordinate = ectomorphy - endomorphy$ and $Y\ coordinate = 2 \times mesomorphy - (ectomorphy + endomorphy)$.

Sexual dimorphism of growth of WT, HT, BMI, PBF, and somatotype at each age-group were analyzed by Student's t-tests. Age-related change of WT, HT, BMI, PBF, and somatotype were examined by the application of ANOVA model and followed by the use of Tukey HSD (honest significant difference) *post hoc* test for multiple comparisons. Associations of sociodemographic indicators to body sizes were analyzed by linear mixed effect models as mentioned by Lindstrom and Bates (1988). For screening the nutritional status of our subjects based on BMI and PBF, we compared them to the accepted conventions of Kuczmarski *et al*. (2000) for BMI and McCarthy *et al*. (2006) for PBF. A child is defined as underweight if BMI is lower than the 5th percentile, at risk for underweight if BMI ranges in the 5th to 15th percentile, normal if BMI ranges in the 16th to 84th percentile, overweight if BMI ranges in the 85th to 94th percentile, and obese if BMI is higher than 95th percentile (Kuczmarski *et al*. 2000). Based on PBF, McCarthy *et al*. (2006) selected the 2nd percentile to define the upper limit of underfat, and the 85th and 95th percentiles to define the lower limits of overfat and obese. All statistical procedures were performed using the R software version 2.9.1 (http://www.R-project.org/).

RESULTS

Sociodemographic Characteristic. A total of 397 girls and 334 boys age 4 to 20 years participated for the study. After eliminating outliers, subjects remained were 363 girls and 299 boys. They were ethnic Javanese living in Magelang Regency of Central Java Province, Indonesia. In average, their family size was 5 and ranged from 2 to12 members. Over half of their parents (58%) had received secondary education (junior and senior high school), 27% attended primary school and only 14% graduated in the college (diploma, bachelor, master, and doctoral). Over half of the fathers (65%) worked as government employee, private employee and labor while about 35% were unemployment or self financed as farmer and entrepreneur. However 33% of the mothers were house wife and about 36% worked as government employee, private employee and labor, while 31% were farmer and entrepreneur. About 40% of the parents had monthly income lower than the regionally minimum salary of Magelang Regency in year 2010. According to the Indonesia's Investment Coordinating Board in 2008 (www.regionalinvestment.com), its value was 752,000 Indonesian Rupiah (IDR). Regionally minimum salary is regulated every year by local government based on the rates of several goods in an area. It is a standard used by industry in paying their labor or their employees. This readily provides a basis to infer middle class segment of community. Over than half of the parents (60%) had monthly income higher or equal to the regionally minimum salary while other 40% were lower (Table 1). Thus most children subjects were categorized in the well-off family.

Body Sizes. Figures 2 and 3 present growth charts of body weight and height, respectively, for Javanese girls and boys aged 4-20 years lived in Magelang Regency. According to the 50th percentile, at age 4 years girl body size were about 13 kg in body weight and 100 cm in body height, while boy's were about 15 kg in body weight and 100 cm in body height. It is apparent from these charts that the body weight and height for both of them progressively accelerated with advancement of age. However, growth chart for girls ceased to grow after 17 years

Table 1. Sociodemographic characteristic of children included the study

Socioedemographic indicators	Girl		Boy	
	n	Percentage (%)	n	Percentage (%)
Family size				
< 4	16	6.72	28	12.84
4-6	195	81.93	175	80.28
> 6	27	11.34	15	6.88
Sibling				
1 (single child)	16	7.41	25	11.57
2-4	205	81.94	177	86.50
> 4	16	7.41	14	6.48
Mother education				
Primary school	66	29.33	52	24.76
Junior high school	56	24.89	57	27.14
Senior high school	67	29.78	74	31.90
College (diploma and bachelor)	36	16.00	27	12.86
Father education				
Primary school	54	23.58	70	32.11
Junior high school	49	21.40	42	19.27
Senior high school	93	40.61	76	34.86
College (diploma and bachelor)	31	13.54	29	13.30
Post graduate (master and doctoral)	2	0.87	1	0.46
Mother occupation				
Household wife	78	37.14	57	28.64
Self financed (farmer, trader, entrepreneur)	60	28.57	67	33.67
Employee (government, private, labor)	75	35.71	75	37.69
Father occupation				
Unemployed	1	0.43	2	0.93
Self financed (farmer, trader, entrepreneur)	82	35.19	71	33.18
Employee (government, private, labor)	150	64.38	141	65.89
Total monthly income of parent*				
Low (< 752,000 IDR)	72	41.62	56	40.00
Medium (752,000-1,500,000 IDR)	38	21.96	40	28.57
High (> 1,500,000 IDR)	63	36.42	44	31.43

n = number of subjects; *Regionally minimum salary of Magelang Regency in year 2010 was 752,000 Indonesian Rupiah (IDR) (Indonesia's Investment Coordinating Board 2008).

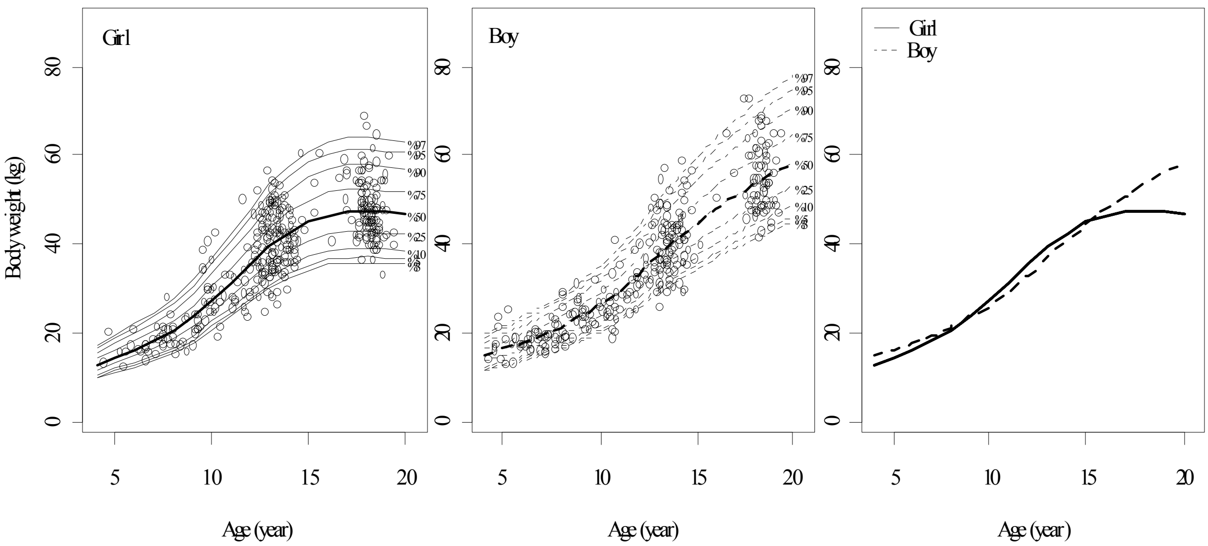

Figure 2. Growth chart of body weight in girl (left, solid lines) and boy (center, dashed-lines) age 4 to 20 years lived in Magelang Regency. Bold line for 50th percentile and others for 3rd, 5th, 10th, 25th, 75th, 90th, 95th, and 97th percentiles (bottom to top). Combined of both sex curves (right) were derived from 50th percentile.

of age. Sex differences existed significantly ($P < 0.05$) after age 12 years. Nevertheless, during age 10 to 15 years girls were heavier than boys. According to the 50th percentile, females at age 20 years were about 11.69 kg lighter and 12.9 cm shorter than males at the similar age.

According to the 50th percentile of BMI growth chart (Figure 4), girls were about 13 kg/m^2 while boys were about 14 kg/m^2 at age 4 years. We found BMI also increase with age in boys, but in girls it ceased to grow after 17 years of age. At age 20 years, BMI of girls were about 19 kg/m^2 and boys were about 20 kg/m^2. Over half of our subjects (65%) were normal and 5% were underweight. Prevalence of overweight in girl was higher than in boys but prevalence of obese was rather similar in both sexes (Table 2). Among

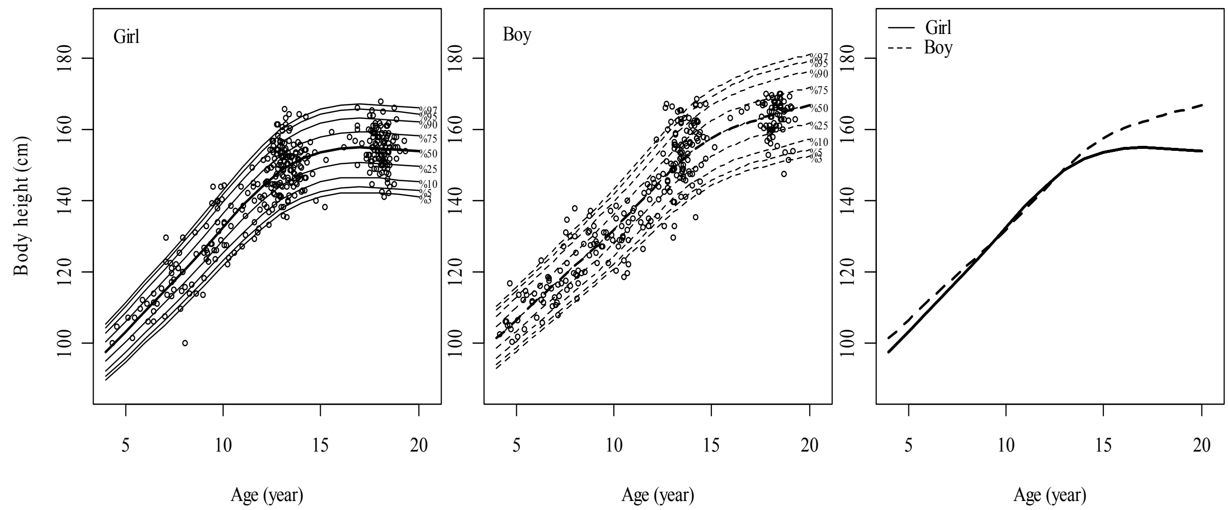

Figure 3. Growth chart of body height in girl (left, solid lines) and boy (center, dashed-lines) age 4 to 20 years lived in Magelang Regency. Bold lines for 50th percentile and others for 3rd, 5th, 10th, 25th, 75th, 90th, 95th, and 97th percentiles (bottom to top). Combined of both sex curves (right) were derived from 50th percentile.

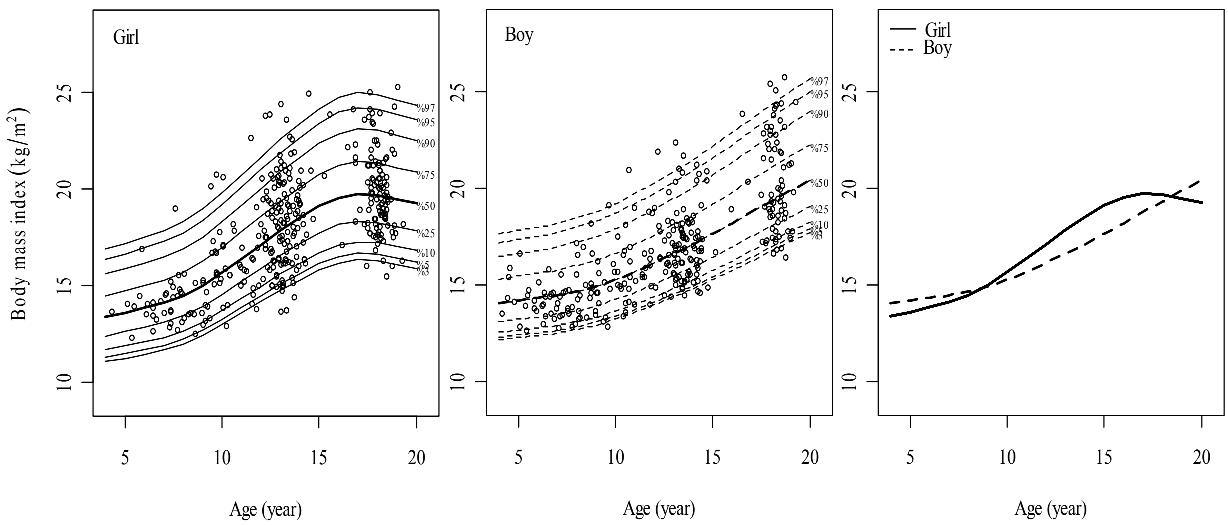

Figure 4. Growth chart of body mass index in girl (left, solid lines) and boy (center, dashed-lines) age 4 to 20 years lived in Magelang Regency. Bold line for 50th percentile and others for 3rd, 5th, 10th, 25th, 75th, 90th, 95th, and 97th percentiles (bottom to top). Combined of both sex curves (right) were derived from 50th percentile.

Table 2. Prevalence of underweight, normal, overweight, and obese according to body mass index (BMI) percentiles and prevalence of underfat, healthy, overfat, and obese according to percentage of body fat (PBF) percentiles among children subjects lived in Magelang Regency

	Girl		Boy	
	n	Percentage (%)	n	Percentage (%)
BMI classification				
Underweight	20	5.81	14	4.95
Risk for underweight	29	8.43	30	10.60
Normal	214	62.21	195	68.90
Overweight	67	19.48	25	8.83
Obese	14	4.07	19	6.71
PBF classification				
Underfat	49	28.00	4	1.91
Healthy	125	71.43	174	83.73
Overfat	0	0.00	19	9.09
Obese	1	0.57	11	5.26

n = number of subjects. According to BMI percentiles: underweight was defined as BMI < 5th percentile, at risk for underweight 5th ≤ BMI < 15th percentile, normal 15th ≤ BMI < 85th percentile, overweight 85th ≤ BMI < 95th percentile, and obese BMI ≥ 95th percentile (Kuczmarski *et al*. 2000). According to PBF percentiles: underfat was defined as PBF < 2nd percentile, healthy 2nd ≤ PBF < 85th percentile, overfat 85th ≤ PBF < 95th percentile, and obese PBF ≥ 95th percentile (McCarthy *et al*. 2006).

the sociodemographic indicators, monthly income of the parent and parents education level were the significant predictors for BMI (P < 0.05) in girl subjects but not in boys. The higher monthly income and the higher education level of the parent, BMI of the girls was higher.

PBF growth charts are shown in Figure 5. In girls, PBF increased for every age from 3 to 17 years but not in boys (Figure 5). PBF of girls grew slightly during age 3 to 6 years. However, after 6 years they accelerated. In boys, PBF fluctuated. They decreased from age 3 to 8 years and then slightly increased for the next 4 years. Since age 12 PBF of boys continued to decrease. Sex differences existed early at about age 6 years. Girls at age 17 years had twice greater of body fat than boys. Based on the PBF values, most subjects (over 70%) in both sexes were healthy. The others were overfat and underfat. Boys were more in overfat and obese state (14%) than girls (0.6%) and subsequently girls were more in underfat state (28%) than boys (2%) (Table 2). Among the sociodemographic indicators, monthly income of the parent and parents education level were the significant predictors for PBF (P < 0.05) in girls but not in boys. The higher monthly income and the higher education level of the parent, PBF of the girls was higher.

Somatotype. Median values of the somatotype components for each age group are presented in Figure 6. We found somatotype varied with sex and age. A significant sexual difference in the three components of somatotype was found (P < 0.05). At age 4 years, both girls and boys had more dominant endomorphy and mesomorphy components. However in the subsequent ages, ectomorphy component increased but mesomorphy component decreased. The decreased of mesomorphy component was parallel to the decrease of endomorphy component in both sexes although from 8 years of age endomorphy component in girls increased instead. The age-related change of endomorphy component in both sexes were significant at P < 0.05. Mesomorphy component in both sexes demonstrates a significant decrease (P < 0.05) with age from 4 to 20 years. At about age 8 years the

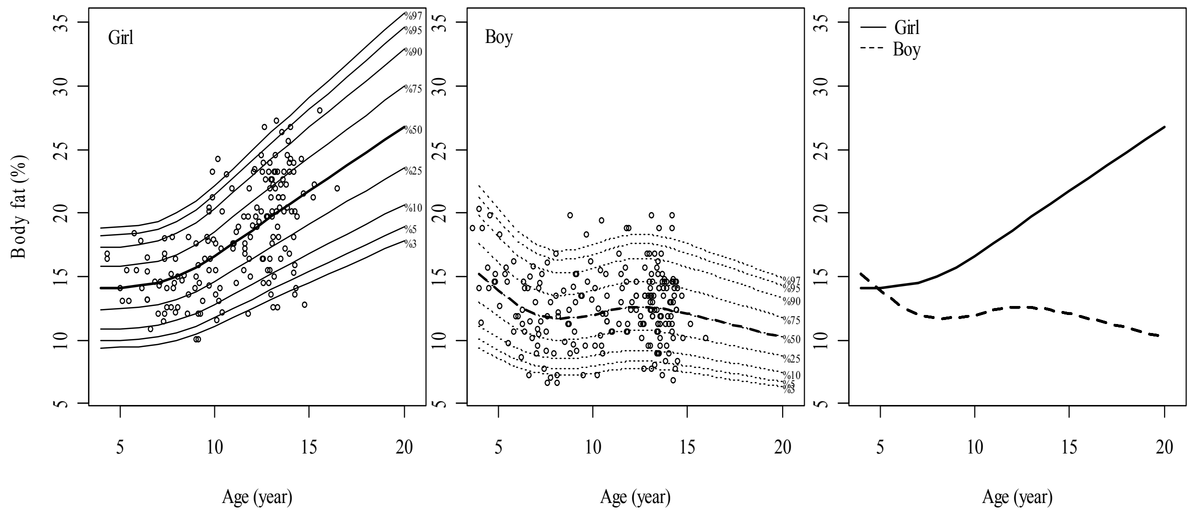

Figure 5. Growth chart of body fat in girl (left, solid lines) and boy (center, dashed-lines) age 4 to 20 years lived in Magelang Regency. Bold line for 50th percentile and others for 3rd, 5th, 10th, 25th, 75th, 90th, 95th, and 97th percentiles (bottom to top). Combined of both sex curves (right) were derived from 50th percentile.

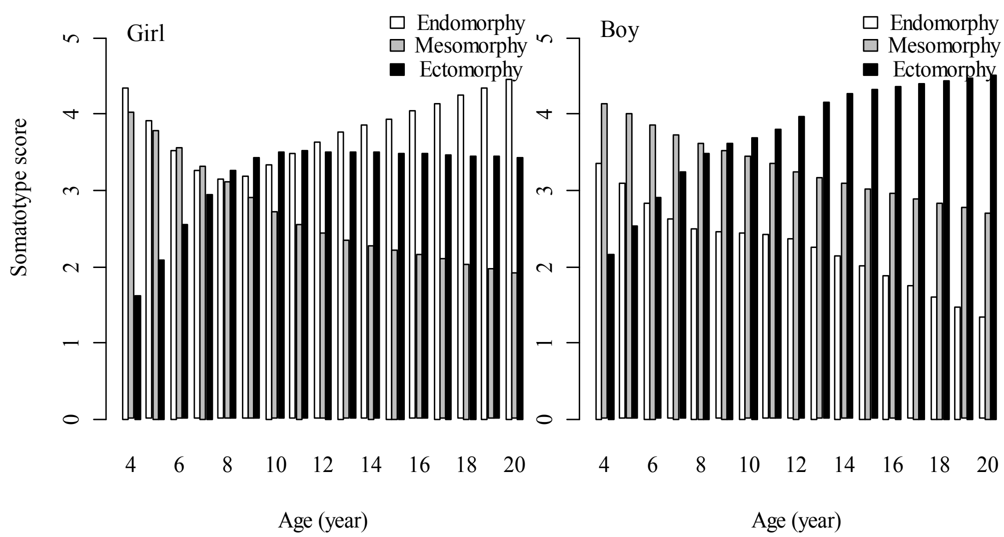

Figure 6. The 50th percentile values of somatotype components score in children age 4 to 20 years lived in Magelang Regency.

three components somatotype in girls tended to be at balance. Since about 10 years of age, ectomorphy component in girls ceased to grow. Nevertheless, ectomorphy component in boys shows a significant increase (P < 0.05). Therefore girls became to be more endomorphic while boys more ectomorphic at the older ages. We plotted median values of somatotype score for each age group to the Carter's somatochart as shown in Figure 7. There is a clear direction of age-related change of somatotype in children at age range 4 to 20 years from balanced mesomorph-endomorph (somatotype score 4-4-2) to central (somatotype score 3-3-3) to ectomorphic-endomorph (somatotype score 4-2-3) in girls and from mesomorph-endomorph (somatotype score 3-4-2) to mesomorphic-ectomorph in boys (somatotype score 1-3-5).

Relationship of endomorphy component to the BMI and PBF were analyzed as shown in Figure 8. There was a positive correlation of endomorphy component to BMI in girls (R^2=0.497, P < 0.05) but not in boys (R^2=0.012, P > 0.05). Nevertheless, endomorphy component correlated positively to PBF in both sexes. All correlations were significant at P < 0.05 with R^2 values were 0.813 in girls and 0.718 in boys. Therefore, BMI in girls correlated significantly to PBF (R^2=0.570, P < 0.05), but not in boys (R^2=0.0001, P > 0.05).

DISCUSSION

This discussion begins with a comparison of the children body size in the present data with those reported for several ethnic to study the population differences in growth pattern. Available data of height and weight were obtained from the studies in Javanese children from Bantul and Yogyakarta Indonesia (Rahmawati *et al*. 2004), Japanese children (Kimura 1984), India children from rural areas in Andhra Pradesh, Gujarat, Karnataka, Kerala, Madhya Pradesh, Maharashtra Sissa, Uttar Pradesh, and Tamil Nadu Provinces (Venkaiah *et al*. 2002), and U.S. children (NHES & NHANES 2002). U.S., Japan and Yogyakarta samples came from families belonging to a relatively higher level of socioeconomic statuses compare to Magelang; hence they had better nutrition and optimum living conditions. In general, Javanese children from Magelang Regency were shorter and lighter than the children of those U.S., Japan and Yogyakarta as shown in Figure 9. They improved when compared with those of the same ethnic from Bantul and with the different ethnic from rural India. Bantul Regency is a rural region with rather similar condition to the Magelang Regency. Bantul is about 60 km south of Magelang Regency. Although Javanese children from Bantul, Yogyakarta and Magelang

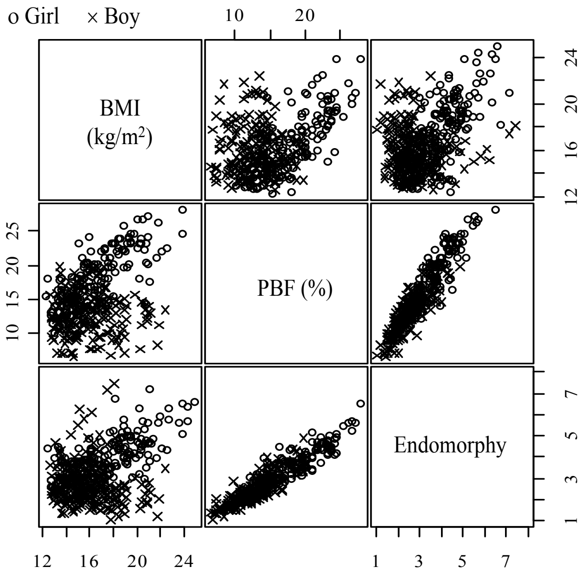

Figure 8. Correlation of endomorphy component of somatotype to the body mass index (BMI) and percentage of body fat (PBF).

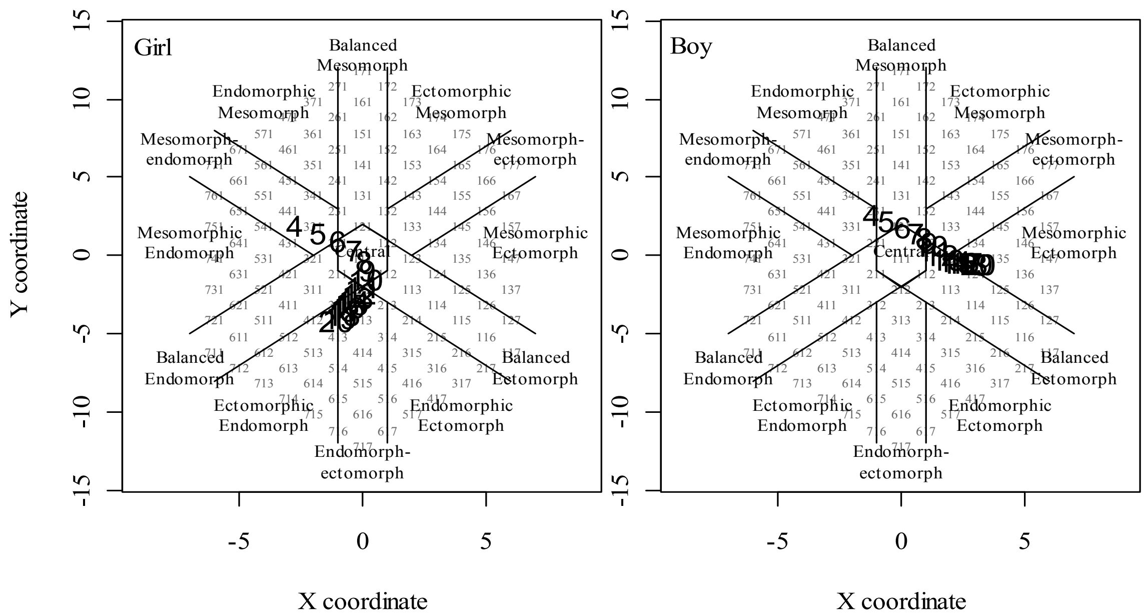

Figure 7. Somatoplot of the 50th percentile somatotype score (bold numbers) of girls (left) and boys (right) lived in Magelang Regency by age, 4 to 20 years.

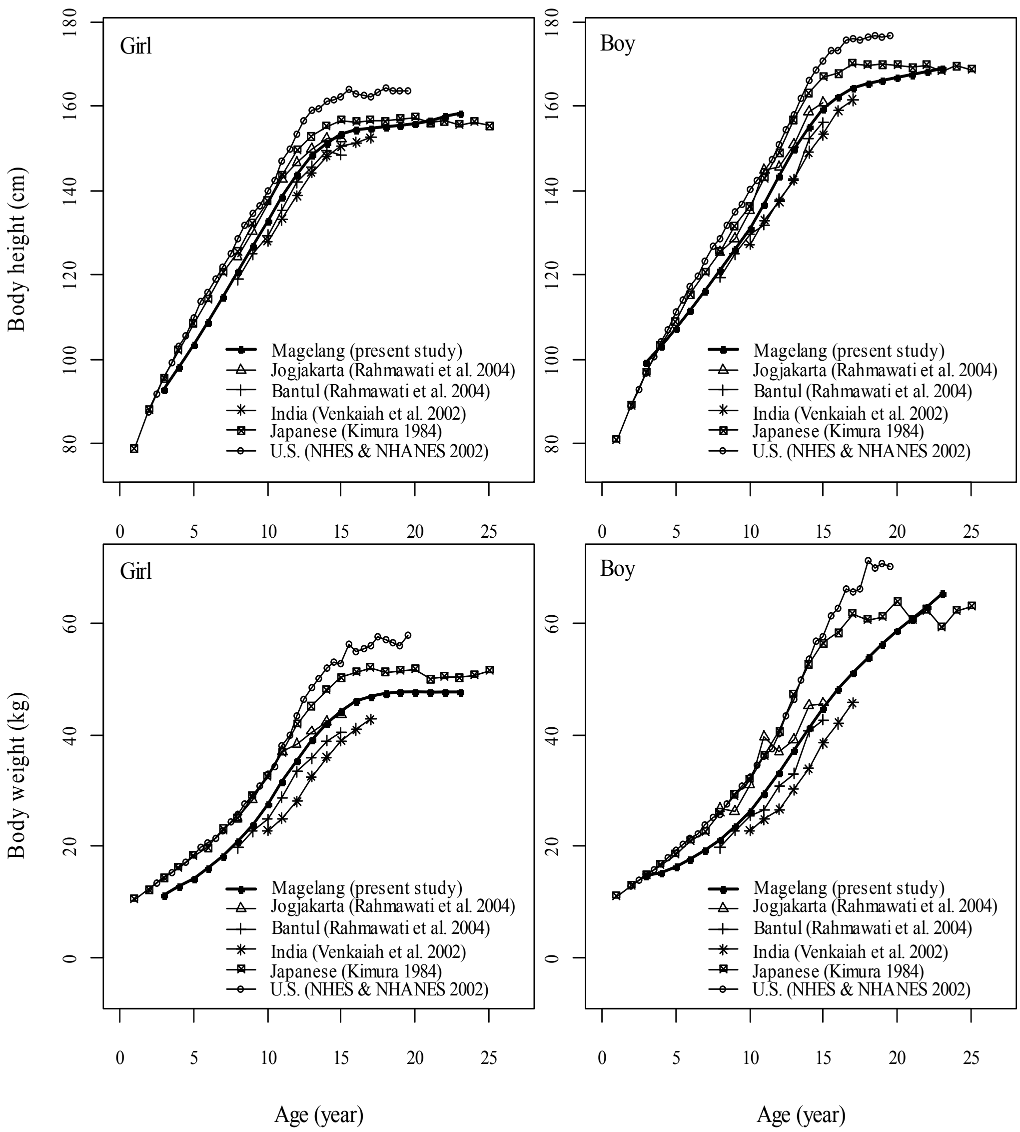

Figure 9. Comparison of body height (top) and body weight (bottom) in Javanese children from the present study with different ethnic groups.

are genetically close to each other compared to India, their growth patterns were different in relation to India. Reference children from the Indian study also lived in rural area with low socioeconomic status (Venkaiah *et al*. 2002) so their height and weight were lower than Javanese children (Yogyakarta, Magelang, and Bantul). Most U.S. sample came from white children which belong to Caucasoid as the Indian so they are rather similar genetically. However, India children from rural area had lower physical growth as the genetic potential would only be expressed in the well-off and healthy populations (Bogin & Sullivan 1986; Thomis & Towne 2006). This was also true for Japanese and Javanese children which are the same Mongoloid race yet Japanese children had greater growth in their body sizes because they live in the better socioeconomic conditions. It is a well known fact that the well-off population has higher physical growth than the poor ones (Jones *et al*. 1985; Shen *et al*. 1996; Mueller & Smith 1999; Rahmawati *et al*. 2004).

During the human growth, the body changes significantly in size, structure, proportions, and composition (Kalichman & Kobyliansky 2006). In our study there was a clear age-related change of somatotype in children aged 4 to 20 years. At age 4 years, the physique of Magelang Regency children in both sexes is found to be mesomorph-endomorph (somatotype score 4-4-2 in girl or 3-4-2 in boy). Thereafter it is transformed into ectomorphic-endomorph (4-2-3) in girls and to mesomorphic-ectomorph (1-3-5) in boys at the age of 20 years. Thus during the growth period, there has been major qualitative changes take place in the physique of a child (Singh *et al*. 2007). Based on the change in somatotypic component, we could determine the onset of puberty (Kulin & Müller 1996). In our girl subjects, it is characterized by an acceleration of endomorphy component and followed by a plateau of ectomorphy component which is shown at age 8 years (Figure 6). It is well known that endomorphy reflects body fat (Carter 2002). According to

Kulin and Müller (1996) and Aryo (2011), girls augment their body fat noticeably at 7 years of age. Nevertheless, according to Davidson *et al*. (2003), it could be exhibited from age 5 to 9 years. Thus our girl subjects were categorized in normal puberty. Onset of puberty in our boys is characterized by an acceleration of ectomorphy exceeded the mesomorphy components. Mesomorphy component decreased gradually during age 4 to 20 years. These pattern of changes are rather similar to the Bandung boys as reported by Aryo (2011) but in Magelang boys the changes occurred later than in Bandung boys. The mesomorphy component reflects muscle and skeletal tissue (Carter 2002). Nevertheless Kulin and Müller (1996) stated that lean body mass, which is made up primarily of muscle and skeletal tissue, increases significantly in boys since age 9 years in Caucasian population. The different pattern of somatotypic component dominance during puberty might deal with ethnicity and socioeconomic condition differences between Magelang and Bandung boys from those mentioned by Kulin and Müller (1996).

We also reported relationships of endomorphy component of somatotype to BMI and PBF. We found endomorphy component correlate significantly to PBF (in both sexes) (Figure 8) as endomorphy reflects body fatness (Carter 2002). However endomorphy component was found not to correlate to BMI in our boy subjects. Although BMI is the most commonly used indirect measure of overall adiposity (Bose & Mascie-Taylor 1997; Bose 2002; Ghosh *et al*. 2004; Bhadra *et al*. 2005), BMI does not quantitate body fat as it amalgamates frame size (mineral content) and lean tissue (Roemmich *et al*. 1997; Fields & Goran 2000). The different growth pattern of somatotypic components between girl and boy showed that the use of BMI as an indicator of fatness in children should be reassessed. Assessment of body fat from skinfolds, as it leads to endomorphy, gives a more direct estimate of body fat mass (Fett *et al*. 2006), especially more so in children and adolescents (Deurenberg *et al*. 1990).

We observed correlations of several sociodemographic factors to body fat. We found that monthly income of parent was the main predictor. This is in accordance to the notion that, socioeconomic status correlates to the body fat across entire range of ethnic groups (Bogin & Sullivan 1986). Several publications worldwide showed that the low socioeconomic status causing children to suffer from mild to moderate energy malnutrition (Jones *et al*. 1985; Shen *et al*. 1996; Mueller & Smith 1999; Rahmawati *et al*. 2004; Water *et al*. 2004). Poor children experience greater reduction in fat storage under nutritional stress. Over half of our subjects (about 60%) were categorized in the well-off children. Their parents had relatively high salary and education level (Table 1). Therefore underweight or underfat prevalence in our subjects was lower (14.3%) comparing to the national survey (27.4%) conducted by Indonesia Family Life in 2000 (Tuan & Nicklas 2009) or comparing to the United Nations System Standing Committee on Nutrition report (26.5%) in 2004 (Leroy *et al*. 2008).

It was conclude that of our children subjects (> 50%) were categorized in the well-off family. Their parents had higher education level with monthly income higher or equal to the regionally minimum salary of Magelang Regency (752,000 Indonesian Rupiah). At age 4 years girl body size were 13 kg in body weight and 100 cm in body height, while boy's were 15 kg in body weight and 100 cm in body height. In girls, BMI were about 13 kg/m^2 and PBF were 14% while in boys, BMI were about 14 kg/m^2 and PBF were 15%. At age 20 years their body size increased. In girls, they were 47 kg in body weight and 150 cm in body height, while boys were 58 kg in body weight and 167 cm in body height. BMI also increased, girls were about 19 kg/m^2 and boys were about 20 kg/m^2. PBF increased to 25% in girls but decreased to 10% in boys. Because of our subjects came from well-off family, underweight or underfat prevalence was low (14.3%). There was a clear age-related change of their somatotype. At age 4 years, the physique of children subjects in both sexes is found to be mesomorph-endomorph (somatotype score 4-4-2 in girl or 3-4-2 in boy). Thereafter it is transformed into ectomorphic-endomorph (4-2-3) in girls and to mesomorph-ectomorph (1-3-5) in boys at the age of 20 years. In girl subjects, the onset of puberty was characterized by an acceleration of endomorphy component which is shown at age 8 years. While in our boys it was characterized by an acceleration of ectomorphy since age 9 years. The different growth pattern of somatotypic components between girl and boy showed that the use of BMI as an indicator of fatness in children should be reassessed.

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